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ABSTRACT

This report describes the efforts of three urban school districts participating in the Urban Schools Science and Mathematics Program (USSAMP) to enhance mathematics and science education in the middle grades and to prepare more African-American, Latino, and female students for career opportunities in technology and science. In Atlanta (Georgia), activities of the USSAMP program included establishing a professional development institute and a Saturday Mathematics and Science Academy, providing increased student supports for math and science, and introducing middle grade students to algebra. The Cleveland (Ohio) effort included activity-based instruction, mathematics and science clubs, mathematics competitions, a school banking program, science fairs, career awareness education, self-esteem building efforts, and professional development, as well as other activities. The Detroit (Michigan) project involved a Saturday Institute as part of teacher professional development, increased school instruction time for mathematics and science, the purchase of materials, family mathematics sessions, and career awareness supports. A final chapter summarizes lessons learned at the three sites in vision formulation, the importance of district-level support, the principal's role, planning, technical assistance, ongoing professional development, minority contributions, access to algebra, and other areas. An appendix lists participants, resources, and members of the Academy for Educational Development Board of Directors. (JB)

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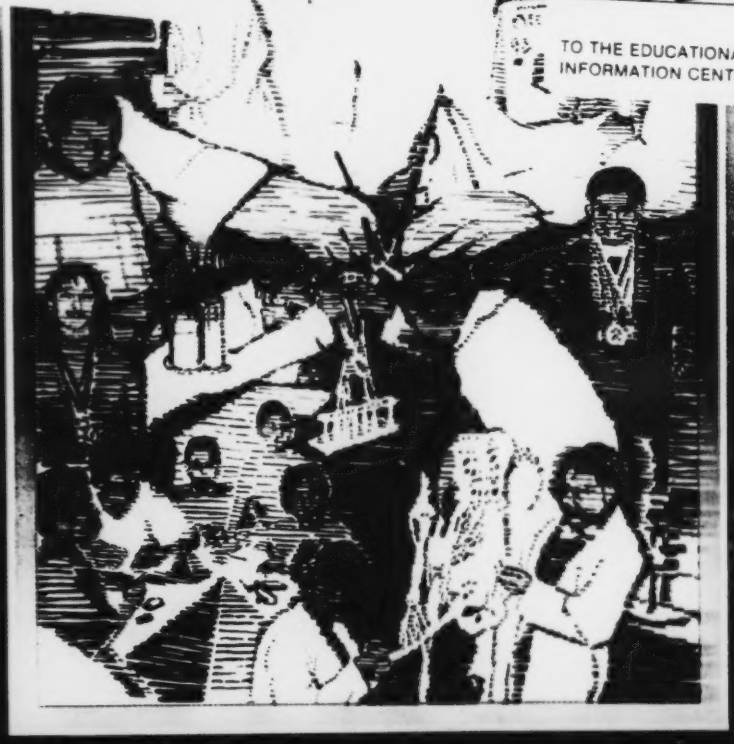

Urban Schools Science and Mathematics Program

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NEW EQUATIONS

The Urban Schools Science and Mathematics Program

by

Elayne Archer

AED

ACADEMY FOR EDUCATIONAL DEVELOPMENT, INC.

1993

Academy For Educational Development

AED is an independent, tax-exempt, nonprofit organization committed to addressing human development needs through education, communication, and information. Under contracts and grants, it operates programs for government and international agencies, educational institutions, foundations, and corporations. Since its founding in 1961, AED has conducted projects throughout the United States and in more than 100 countries in the developing world. In partnership with its clients, AED strives to increase access to learning, to improve the functioning of educational institutions, and to expand the sphere of education to social and economic development.

The School and Community Services department has a strong commitment to excellence and equity in education and to developing links between schools and community agencies to increase educational and development opportunities for at-risk youth across the United States. Staff and consultants have extensive experience working with large urban school systems, community organizations, and foundations and other funding agencies on programs addressing critical educational issues, such as dropout prevention, adolescent pregnancy and parenting, literacy, and youth employment and training.

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FOREWORD

For several years it has been our privilege to oversee the Urban Schools Science and Mathematics Program (USSAMP). The program, sponsored by the Ford Motor Company and the U. S. Equal Employment Opportunity Commission, was initiated in response to growing concern about the underrepresentation of African-Americans, Latinos, and females in precollege mathematics and science courses and in careers in science and technology.

In the fall of 1989, Ford Motor Company awarded grants to three urban school districts to support activities to improve the mathematics and science achievement of African-American, Latino, and female middle-grades students in three cities where Ford had a large corporate presence: Atlanta, Cleveland and Detroit. Over the next two years, participating schools undertook a number of innovative activities to enhance the teaching and learning of mathematics and science.

USSAMP was fueled by a vision of equity: that African-American, Latino, and female students could reach high levels of achievement in both mathematics and science, given high teacher expectations, effective curriculum and teaching strategies, and adequate curricular and non-curricular supports. The USSAMP experience shows that this is true. This report provides many examples of the excellent work in mathematics and science that African-American, Latino, and female students can achieve. It describes these activities in detail in the hope that other middle-grades educators will be inspired to work to improve the mathematics and science education and achievement of these students.

USSAMP also provides an excellent example of a growing trend in American education: a dynamic partnership between the corporate sector and the schools to improve educational opportunities for disadvantaged youth. The program is evidence of Ford Motor Company's ongoing commitment to equity in the workplace and of the corporate sector's commitment to improving educational opportunities for disadvantaged youth. We hope that this report will encourage other members of the corporate sector to work in partnerships with schools and school districts to improve the educational achievement of disadvantaged youth and to prepare them for the challenging workplace of the future.

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We acknowledge the contributions of the many individuals who participated in the USSAMP projects: district-level staff, who showed leadership in undertaking innovative approaches to mathematics and science education in their districts; project staff and teachers, who pioneered new approaches to improving middle-grades mathematics and science teaching; and students, who were a source of inspiration to those who worked with them daily. The following project participants attended the May 1992 USSAMP conference in Washington, D.C. and offered valuable insights into what made their projects effective: James Bateman, Juanita Clay Chambers, Charlene Coats, Mildred Coats, Linda Danns, Gloria Jackson, Weyman Patterson, David Porter, Leviticus Roberts, Melvin Webb, and Linda Wood. The representatives of other schools and districts engaged in mathematics and science education reform who attended this conference also made a valuable contribution.

We especially thank Juanita Clay Chambers of Detroit Public Schools, Weyman Patterson of Atlanta Public Schools, and Mayethel White of Cleveland Public Schools, who tirelessly read and reread the chapters describing the USSAMP projects in their cities.

Several Academy for Educational Development colleagues and former colleagues were critical to this program and report: Sandra Jibbrell, former program director, initiated USSAMP and provided its spirit and vision; Sharon Franz, senior vice president, guided the development and progress of the project; Veena Kaul, program coordinator, was involved with USSAMP from the beginning and provided guidance and enthusiasm throughout the implementation and documentation of the project;

Alexandra Weinbaum, AED senior program officer, offered feedback on one of the drafts; Patricia Iorfino, Dorothy Nixon, and Paula Vincent provided word processing support; and Ray Valdivieso, vice president and director, provided encouragement during the final stages of the project.

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Anne Galletta
Program Officer

Elayne Archer
Senior Consultant

December 1992

"I never knew how exciting math and science could be. Now I am flying higher and higher in math and science."

Saturday Academy student in Atlanta

CHAPTER ONE

INTRODUCTION

Children of color and females need opportunities to make connections with mathematics and science, to see them as related to the real world and their every day lives. They need to understand their history in these fields, and to see the connections between mathematics and science and possible future careers. — Member of USSAMP technical assistance team

This report describes the efforts of three urban school districts, participating in the Urban Schools Science and Mathematics Program (USSAMP), to enhance mathematics and science education in the middle grades. It reflects the experiences of educators in the three project cities, as well as those of other educators engaged in middle-grades mathematics and science reform activities, and describes many of the lessons learned from this work. The major purpose of this report is to encourage and assist educators to undertake activities to improve the teaching of middle-grades mathematics and science.

The Academy for Educational Development (AED) initiated USSAMP in the fall of 1988 with support from the Ford Motor Company under an agreement with the U.S. Equal Employment Opportunity Commission. The goal of the program was to prepare more African-American, Latino, and female students to take advantage of career opportunities in technology and science. To achieve this, USSAMP sought to enhance the quality of middle-grades mathematics and science education so that more African-American, Latino, and female students would enter high school prepared to take advanced courses in these subjects. The program was implemented in three cities where the Ford Motor Company had a strong corporate presence — Atlanta, Cleveland, and Detroit.

Major Assumptions

USSAMP was grounded on three major assumptions:

- African-American, Latino, and female students can reach high levels of achievement in both mathematics and science, given high teacher expectations, effective curriculum and teaching strategies, adequate curricular and noncurricular supports, and access to critical courses (such as algebra).

- Improvement strategies should focus on the middle grades, where science and mathematics curricula become more challenging and where mathematics choices and performance can become decisive factors in future educational and career choices.
- Algebra is a critical factor in determining African-American, Latino, and female students' access to advanced high school mathematics and science courses and to careers in science and technology.

Background

AED developed USSAMP in response to growing concerns about the quality of mathematics and science education in our public schools. Various studies have concluded that U.S. schools are not adequately preparing large numbers of students for participation in the workplace of the future. In 1983, the National Science Board's Commission on Precollege Education in Science, Mathematics, and Technology concluded that "alarming numbers of young Americans are ill-equipped to work in, contribute to, profit from, and enjoy our increasingly technological society."[1] This situation has not changed dramatically in the past ten years and will only worsen as new technologies continue to require an ever more literate and flexible workforce — and as the science and technical competencies required in existing jobs increase.

Other concerns pertain to issues of equity in mathematics and science education. In general, African-American, Latino, and female students receive less precollege mathematics and science instruction and perform at lower levels on standardized tests than do white male students. Their participation and achievement in postsecondary mathematics and science courses is low, and they are severely underrepresented in mathematics- and science-related professions. African-Americans, Latinos, and females receive a disproportionately small number of degrees in mathematics, engineering, and the physical sciences, and hold a small proportion of jobs in these fields: in 1989, 3 percent of scientists and engineers were African-American, 2 percent were Latino, and 12 percent were women.[2]

Middle-Grades Mathematics and Science Education

> *When USSAMP was initiated, in many urban school districts there was a general apathy to mathematics and science on the part of teachers, administrators, and students, and little movement for change. Many students could move through the middle grades without receiving a full year of science. There was a general reliance on textbooks, little activity-based learning, and almost no technology. There were few opportunities for the average student to make the connection between mathematics and science and future careers. And there was no concept of "algebra for all students."* — Member of USSAMP technical assistance team

The low participation and achievement of African-American, Latino, and female students in advanced mathematics and science courses derive from a number of factors. Chief among them are the following:

- *Outmoded middle-grades mathematics and science curricula.* Middle-grades mathematics and science curricula are overly dependent on textbooks and methods of instruction that emphasize drill and rote learning and the acquisition of arithmetic facts, rather than on problem solving and higher-order thinking skills. Typically, curricula are almost completely lacking in activity-based instruction and offer limited hands-on activities to help students make the connections between mathematics and science and real-world experiences and future career opportunities.
- *Insufficient preparation of middle-grades mathematics and science teachers.* The quality of middle-grades mathematics and science instruction is uneven. Middle-grades mathematics and science teachers are often unprepared to teach the subjects effectively, especially given emerging technologies and the increased need for activity-based approaches. Many do not have credentials in the subject areas. This situation may have a greater impact on the achievement of African-American and Latino students than on white students, since mathematics and science teachers of African-American and Latino students are often not specialists but hold K-8 certification. Further, in many school systems the least credentialed teachers are placed in the poorest schools.*

* This is not to suggest that many teachers who lack credentials in specific subject areas are not excellent teachers. In fact, in alternative schools across the country, many creative teachers without credentials in specific areas are teaching. However, given new curricula, approaches, and emerging technologies in mathematics and science education, being credentialed may be critical for effective teaching.

- *Lack of ongoing professional development in mathematics and science.* Many school districts do not provide the professional development necessary to keep teachers abreast of new content and innovative teaching strategies in mathematics and science and to enable them to provide motivational experiences for students and help students apply what they have learned to real-world situations. Further, teachers have few opportunities to share with and learn from their peers.
- *Absence of physical science and algebra in the middle-grades curriculum.* Many middle-grades students do not take science and mathematics every semester. In particular, physical science is often treated as an elective. And many middle-grades schools do not offer prealgebra or algebra courses to the majority of students.
- *Lack of resources.* Urban schools do not have the materials, equipment, and textbooks required to provide students with a quality education in mathematics and science; some do not have the resources to provide teachers with the professional development necessary to promote effective use of new technology and textbooks.
- *Insufficient guidance and support services.* Schools often provide insufficient guidance to enable students to select courses wisely. In many schools, guidance counselors are overwhelmed by unrealistic student-counselor ratios and may be unable to provide adequate counseling. Additional supports, such as mentoring, tutorials, and career-awareness education, may also be limited or lacking. These factors may be particularly damaging to students in the lower tracks, who tend to receive less counseling and fewer supports, and who may lack networks in their lives and communities to promote and support their interest in mathematics and science.
- *Tracking of African-American, Latino, and female students.* Teachers and guidance counselors often have low expectations for African-American, Latino, and female students in terms of their science and mathematics achievement. Consequently, these students are frequently tracked into low-level mathematics courses, limiting their access to algebra and advanced courses, like calculus, needed for college science and engineering programs and for many jobs. Further, many schools have insufficient

support services, such as tutoring and mentoring, to help African-American, Latino, and female students succeed in upper-level mathematics and science courses they do manage to take.

Program Description

Three major components formed the basis of USSAMP's strategy to increase African-American, Latino, and female achievement in mathematics and science in the middle grades:

- Revised mathematics and science curricula, focusing on problem solving, higher-order thinking skills, integrating new technologies into the classroom, and making instruction and content relevant to daily life and to the workplace
- Effective professional development, including training on revised curricula, aimed at increasing knowledge of new approaches in teaching mathematics and science and changing teachers' perceptions of the abilities of African-American, Latino, and female students in these subjects
- Improved academic and nonacademic supports, including counseling, career awareness activities, mentoring, tutoring, and motivational supports

Three urban school districts — Atlanta, Cleveland, and Detroit — with large African-American and Latino populations and a strong Ford Motor Company corporate presence — were chosen as USSAMP sites. In 1989, each of the districts received a $5,000 planning grant. The major purpose of the planning period was to enable districts to conduct comprehensive assessments of middle-grades mathematics and science education and to develop overall strategies for improvement. Other important planning activities for each district were the selection of participating schools, the convening of a planning team, a two-day retreat, the design of an improvement strategy responsive to local needs and resources, and the writing of a proposal.

District planning teams included central office administrators; middle-grades administrators and teachers; representatives of business, industry, and community-based organizations involved in mathematics and science education; and parents. The team was responsible for evaluating the district's needs and capacity in mathematics and science education, and for submitting a proposal to AED. In assessing the situation, planning teams considered student achievement in mathematics and science; the strengths and weaknesses of mathematics and science curricula in the middle

grades; professional development activities for middle-grades mathematics and science teachers; the levels and kinds of academic and nonacademic student supports in science and mathematics; existing exemplary mathematics and science programs and activities; and the extent of involvement of business, industry, institutions of higher learning, and cultural and community-based organizations in the district's science and mathematics programs.

AED encouraged districts to develop strategies and solutions responsive to local needs and resources, within certain guidelines:

- Programs were to be school-based and targeted to the middle grades.
- District approaches were to be collaborative, drawing as much as possible on existing community efforts, resources, and expertise, and including representatives of industry, business, postsecondary institutions, and community-based organizations, as well as families.
- District responses were to contain some element of the three basic USSAMP components described above: curriculum development, enhanced professional development, and increased and improved student supports.
- Programs were not to be remedial, but were to focus on preparing more African-American, Latino, and female students to take advanced mathematics and science courses and to pursue careers in science and technology.

AED convened a national advisory panel of experts in mathematics and science education to provide guidance to the program and keep it abreast of the latest trends and research in mathematics and science education. AED also convened a technical assistance team to help the sites plan their projects. (The appendix lists the names of both advisory panel and team members.) Members of the advisory panel and the technical assistance team reviewed the proposals, provided feedback to the school districts, and suggested changes. Representatives from two of the districts attended an intensive two-day planning meeting in Washington, D.C. at which AED program staff helped them design their projects. Following approval of final proposals, USSAMP awarded grants of $350,000 each to Atlanta, Cleveland, and Detroit Public Schools.

The proposals had a number of common elements to ensure an increase in the number of African-American, Latino, and female students from the target schools who would be interested in and prepared to succeed in col-

lege preparation mathematics and science courses. These common elements formed the basis of the vision that shaped USSAMP activities in the participating districts. This vision addressed three areas of concern — academic excellence, equity, and student supports, as outlined in the box below.

Academic Excellence

Highly knowledgeable and capable teachers
High content curriculum
Resource-rich learning environment

Equity

High teacher expectations for all students
High student expectations and self-esteem
Equal access of all students to information and opportunities

Student Supports

Increased and improved supports for students
Support and involvement of families
Support and involvement of community-based organizations and business

The next three chapters describe the approaches and strategies that each school district undertook to make this vision a reality. The last chapter summarizes the lessons USSAMP activities yielded about enhancing mathematics and science education in the middle grades.

Endnotes

1. Commission on Precollege Education in Science, Mathematics, and Technology, *Precollege Education in Science, Mathematics, and Technology* (National Science Board: Washington, D.C.: 1983), as cited in Sandra Brock Jibrell, "Business/Education Partnerships: Pathways to Success for Black Students in Science and Mathematics," *Journal of Negro Education* (Vol. 59, No. 3, 1990).

2. Task Force on Women, Minorities, and the Handicapped in Science and Technology, *Changing America: The New Face of Science and Engineering* (Washington, D.C.: National Science Foundation, 1989).

CHAPTER TWO

THE ATLANTA USSAMP PROJECT

In my school, we don't talk about basketball superstars. We talk about mathematics and science superstars. The kids in the science club have begun to hang out together — they're so proud of doing well in math and science. — USSAMP principal

Introduction

In 1989, Atlanta Public Schools (APS) had a total enrollment of 64,000 students, 93 percent of whom were African-American. Spurred on by districtwide standardized tests scores that were lower than the national average in mathematics and science, in 1985, APS had undertaken a systemwide effort to improve student achievement in these areas, especially in the middle grades. This initiative included curriculum revision, professional development, and school visitations by a special team of resource personnel. Strong collaborations between the school system, businesses, and institutions of higher education enhanced these activities. This effort led both to increased student achievement in mathematics and science and to a clear picture of the urgent need to continue looking for new ways to improve middle-grades mathematics and science education. APS viewed USSAMP as an excellent vehicle for doing this.

The Planning Period

In response to AED's invitation to participate in USSAMP, the APS superintendent appointed an ad hoc committee of central office personnel and middle-grades educators and administrators to begin work on the planning process and, specifically, to organize the two-day planning retreat. The committee requested that the APS Department of Research and Evaluation conduct a needs assessment on middle-grades science and mathematics education and report on its findings at the retreat.

The retreat took place in July 1989. At that time, the full planning team — made up of members of the ad hoc committee and representatives of business and industry, community-based organizations, postsecondary institutions, the target schools, and the SouthEast Consortium for Minorities in Engineering — appointed the APS mathematics and science coordinator to be the planning team leader. The planning team held follow-up

sessions in August and September to design the USSAMP project and prepare the proposal for submission to AED.

The Target Schools

Early in the planning period, the planning team selected two middle-grades schools considered typical for the district — Martin Luther King, Jr. and John F. Kennedy Middle Schools. King had an enrollment of 850 students, of whom 93 percent were African-American and 89 percent were from low-income families. Kennedy had an enrollment of 700 students: 100 percent were African-American, and 82 percent came from low-income families. In 1989, student achievement (as measured in standardized tests) was below the national average in both mathematics and science at King. At Kennedy, students' science performance was above the national average; however in mathematics, achievement was well below the national average.

Middle-Grades Mathematics and Science Education

The planning team undertook an assessment of middle-grades mathematics and science education, which revealed a picture similar in many ways to the situation described in chapter 1. The team noted the poor preparation of many APS middle-grades mathematics and science teachers. In the system as a whole, 50 percent of science teachers and 25 percent of mathematics teachers had credentials in the subject areas. At the target schools, only 30 percent of science teachers (2 of 7) and 9 percent of mathematics teachers (1 of 11) were certified in their subject area. In the words of a middle-grades principal, "Many teachers were good arithmetic teachers, but they simply didn't have a solid mathematics and science background."

As part of the assessment, the planning team included a survey of mathematics and science teachers and administrators at the two participating schools. Many teachers spoke of a general lack of activity-based instruction in science and mathematics and emphasized a need for ongoing professional development to keep teachers abreast of new content and innovative teaching approaches. They reported a lack of equipment for involving students in mathematics and science activities and a lack of advanced textbooks. Teachers also cited a dearth of opportunities allowing them to share with and learn from their peers. The assessment further revealed that many APS students did not receive physical science instruc-

tion in the eighth grade, and that many did not receive algebra or prealgebra instruction in the middle grades.

A major strength that the needs assessment identified was what one planning team member described as a "premier coalition between the community and public education." This coalition included a number of local colleges and universities, and specifically several historically Black colleges with a strong commitment to teacher education in mathematics and science. These institutions provided a number of exemplary programs for APS students and teachers:

- A Saturday Science Academy conducted by Clark Atlanta University, exposing over 200 APS students to activity-based science and mathematics education
- An eight-week intensive summer program for 60 high school students in science, mathematics, and engineering provided by the Resource Center for Science and Engineering at Clark Atlanta University
- A summer enrichment program emphasizing health careers at Morehouse College
- The Woodrow Wilson series of workshops hosted at Spelman College during the summer for high school mathematics teachers
- A summer mathematics degree program for high school mathematics teachers at Emory University
- Summer workshops for teacher-trainers in schools sponsored by the SouthEast Consortium for Minorities in Engineering, which also provided small grants to schools for field trips

The planning team cited the existence of these outstanding partnerships in the district as a strength on which USSAMP could build.

Program Description

The Atlanta project, called MS=K^2 (Mathematics and Science = King and Kennedy), began in May 1990. Its overall objectives were the following:

- Increase the effectiveness of middle-grades teachers in providing mathematics and science instruction — and, specifically, to increase teacher skills and knowledge in teaching algebra
- Improve student motivation, knowledge, and performance in science and mathematics

- Provide all students in the two schools with the opportunity to advance from arithmetic to prealgebra in seventh grade and to take prealgebra or algebra in the eighth grade

One of the major activities that the Atlanta USSAMP project undertook to achieve these goals was the Mathematics and Science Training Institute.

Mathematics and Science Training Institute

We're training the teachers in one part of the building and working with students in another. It's great for the students to see their teachers up on Saturday morning excited about math and science. — APS mathematics and science coordinator

The Mathematics and Science Training Institute (MSTI) opened in the fall of 1990. MSTI's overall goals were to enhance the teaching of mathematics and science in the middle grades and to increase the number of students entering high school who were interested in pursuing advanced courses in these subjects and were prepared to do so. Located in the King Middle School, MSTI has two major components: a professional development institute, offering teachers training in innovative approaches and strategies to teaching science and mathematics, and a Saturday Mathematics and Science Academy, offering students mathematics and science enrichment and support services. Classes for both teachers and students take place on Saturday mornings throughout the school year.

Professional Development Institute

The goal of MSTI's professional development institute is to enhance the effectiveness of middle-grades teachers in providing mathematics and science instruction. Specifically, the objective is to increase the number and quality of hands-on experiences offered to students in mathematics and science. At MSTI, mathematics teachers receive training in new teaching methods and content, the use of computers and calculators, creating data bases and spreadsheets, and desktop publishing. They undergo special training in strategies to use technology creatively to expand and deepen the mathematics curriculum. Teachers also receive training in helping students progress from arithmetic to algebra and in teaching algebra effectively. This training uses the methods and approaches of the Algebra Project.* Science teachers participate in intensive training in promoting activity-based science. In a two-semester course, teachers perform

*The Resources section contains a description of the Algebra Project and of the other curricula and programs (for which information was available) mentioned throughout this report.

as many as 30 experiments. As the APS mathematics and science coordinator, who was also the MSTI director, put it:

> Teachers need hands-on experience as much as students do. If you want to get teachers to do experiments in the classroom, you have to put them in contact with people who already know how to do those experiments.

Toward the end of the second semester, teachers in the professional development component are brought together with the students in the Saturday Academy. According to the MSTI director, "The Institute becomes a practicum. The teachers become student teachers again to see if they can perform the experiments they've learned." Teachers agree that such experiences are invaluable. One teacher said, "I feel like a student again at MSTI. You really need ongoing opportunities to retool. Teachers can get rusty." MSTI also offers teachers important opportunities for collegial interaction and networking. The principal of one of the participating schools explained:

> The Academy provides teachers with a collegial atmosphere. They start to hang out together. They don't talk about how to keep students' attention anymore — but about how to get a tough math concept across to them.

By December 1992, all mathematics and science teachers at the two original USSAMP schools and at two additional schools — C. W. Long and J. D. Price Middle Schools — had participated in training. Two master teachers (APS high school teachers), collaborating with faculty from Clark Atlanta University, provided the training. Participating teachers received a stipend and staff development credits.

The Saturday Mathematics and Science Academy

The strongest thing about the Saturday Academy program was the way in which the curriculum was delivered. We made everything as active as possible. We put skills in concrete form. — Saturday Academy director

MSTI's Saturday Mathematics and Science Academy offers middle-grades students mathematics and science enrichment and supports. The program, modeled after the nationally acclaimed Clark Atlanta University Saturday Science Academy, provides students in grades 6–8 hands-on science, mathematics, and computer instruction on Saturday mornings throughout the year. In 1991–92, 200 students were enrolled (50 per school), and an average of 165 students attended each Saturday. Students

are selected from participating schools on the basis of interest, and the principal makes the final selection. A core committee of involved parents helps with recruitment. In fall, 1992, this committee had 18 parents, 15 of whom enrolled in a MSTI computer literacy class that paralleled a class provided for teachers.

Students performing science experiments for fun and prizes during Math/Science carnival

While attendance at the Academy was initially poor, it grew dramatically after the Academy offered breakfast and lunch. A typical Saturday at the Academy begins with a hot breakfast. According to director, "A whiff of those biscuits alone would keep you coming back for more!" The hot lunch has improved student attention span (a cold lunch was initially provided), and, the director observed, "makes it more festive and pleasant. The students love to eat together and share their experiences of the previous week."

The original schedule of classes called for three classes — science, mathematics, and computers — from 8:30 a.m.–12:00 p.m., but experience proved that the classes were too short. The program planners revised the schedule to include two longer classes each Saturday, with each class being taught at least once in two weeks.

The director describes the major goal of the Academy in terms of mathematics as follows:

> We do everything from a hands-on perspective to make the students love math and to help them to achieve in math. We don't use a text,

> but we do give homework, and we give students all kinds of awards and praise for completing assignments.

The first-semester curriculum includes number operations and computations, estimation, and exploring relationships between whole numbers, fractions, decimals, ratios, and proportions. The second semester covers algebra, geometry, and statistics. Students work individually and in groups exploring, conjecturing, analyzing, and applying mathematics in both a mathematical and a real-world context. The director reports:

> Everything is "Discover this and discover that." We don't tell the students how many degrees there are in a triangle: we have them discover the number of degrees in a triangle by measuring the angles. They measure the length of the hypotenuse and the other sides, and discover the relationship between the two. What better way to teach measurements than to have students measure?

Typically, one activity includes many components and leads to more abstract concepts and skills. For example, to determine the validity of Leonardo da Vinci's claim that a man's height equals his arm span, Academy students measured heights and arm spans; recorded and charted the data; made scattergrams; determined the relationship between heights and arm span, and the slope of the line connecting the two; and expressed this relationship as an equation. Lastly, students used calculators to confirm solutions they had already worked out. "This way," the Academy director explains, "the students could really see the connections. It is so important for them to discover things rather than to be told."

Students using hands-on approach to solving math problems during Saturday Academy

In the computer course, students learn data base, word processing, spreadsheet, and computer programming. Teacher collaboration ensures that concepts learned in the computer class support those learned in the mathematics class. Students also learn desktop publishing in a lab set up for that purpose (with support from, among others, the local unit of Apple Computers and the local Ford Motor Company).

The science curriculum is as activity-based as the mathematics curriculum. Students explore physical science by measuring mass and volume (in metric units); determining the properties of matter; studying the density of solids and liquids; classifying matter through use of the periodic table (identifying elements, compounds, and mixtures); determining relationships between solubility and temperature; and classifying substances as acids and bases, using known or unknown substances, such as household products. Students also study work, power, and simple machines; light, observing the separation of colors; and the principles of bridge building (the beam and truss).

Academy staff currently number six: three master teachers and three teachers trained at MSTI. A master teacher and teacher trainee are paired in each of the Academy's subject areas — mathematics, science, and computers. One of the keys to success, according to the director, is enthusiastic and well-trained teachers: "Our staff are well-versed; they are comfortable with hands-on applications. Our teachers grow with the kids — they become better teachers."

Students speak enthusiastically of the benefits of the Academy:

> When I came here, I didn't think I would be able to do the work — I thought it would be too hard. But as I got to know the teachers, they helped me and stood by me. My teachers taught me to believe in myself and to take learning seriously. They helped me to do advanced work, and as I learned, I had fun. I grew to believe in myself, and I got so I could do problems in my sleep!

> What I learned at the Saturday Academy helped me with my class work and my schoolwork. It will help me next year when I take algebra. The way the program encourages us to want to learn is great!

Besides classes in mathematics, science, computers, and desktop publishing, Academy students attend seminars in career awareness and go on field trips focusing on careers in science and technology — for example, to the nearby space flight center. Equally important, students learn about the contributions of Africans and African-Americans to mathematics and science, which Academy staff view as crucial to helping students make

a connection with mathematics and science. This information is integrated both into the regular curriculum and into the weekly closing ceremonies. Typically, closing ceremonies also include value lessons, self-esteem exercises, and student recitation of the Academy motto: "We are preparing ourselves to be winners right now and in the year 2000." The Academy director describes one of these closing ceremonies vividly:

> We were in the middle of our closing ceremonies when the science students came out a little late. This wasn't unusual — they are often late because they are determined to finish those experiments. They had been observing the separation of colors in a class on chromatography. They came out holding up pieces of wood with strips of paper — with all kinds of color. They were so excited! They marched right down the aisle — it was festive, like a parade. Well, we just had to stop and acknowledge them. They were so proud of what they had accomplished. They gave a whole lesson on the separation of colors right there.

Other Activities

In addition to establishing MSTI, the Atlanta USSAMP project undertook several other activities to improve the mathematics and science achievement of African-American and female students. These included providing increased student supports for mathematics and science and introducing middle-grades students to algebra.

To provide tutorial and enrichment support for students, the project developed after-school and summer programs. The after-school centers in King and Kennedy provided mathematics and science enrichment, counseling, and self-esteem activities. Teacher-supervised college students staffed the centers, which students could use on a voluntary basis. USSAMP also developed a summer enrichment program, the major component of which was the Summer Science and Mathematics Academy, a half-day program staffed by two high school mathematics and science teachers. For two summers, 240 King and Kennedy students participated in the program, which gave students hands-on instruction in science, mathematics, and language arts related to mathematics and science. Although successful, this program faces an uncertain future, given funding difficulties.

The Atlanta project also sought to enhance the capacity of mathematics and science teachers in King and Kennedy to teach algebra. Fourteen teachers in the two schools completed 100 hours of training during the

spring and summer of 1990 to improve their competency in this area. A professor from Clark Atlanta University assisted with the project, which used the Algebra Project approach. Under USSAMP, the Algebra Project developed a guidebook, *MARTA-LINE Algebra (Moving Algebra Rapidly to Atlanta Middle Schools)*. The guidebook was supported in part by Atlanta's Metropolitan Area Rapid Transit Authority (MARTA) and included exercises based on the transportation system: for example, the transportation line was used as a number line. The USSAMP MARTA-Line Algebra Project was featured in a television series "Restructuring to Promote Learning in America's Schools." Ultimately, MSTI incorporated the Algebra Project methods into its program.

USSAMP Continued

Four middle-grades schools are currently involved in MSTI. Institutionalization plans call for the addition of more middle schools every year through 1995, by which time APS hopes to have involved all middle-grades schools. Ultimately, four MSTI sites are planned where every middle-grades student can receive enrichment in mathematics and science, and every middle-grades mathematics and science teacher can receive professional development. It is hoped that APS staff development funds and APS Parenting Center funds will help support this expansion, and that other elements of the program — like the hot meals which school funds cannot pay for — will receive funding from local organizations and industries. Plans are also underway to develop mathematics and science olympiads. These will follow the World Olympics format and will serve as a forum for students to demonstrate the research and problem-solving skills they have learned both in school and in the Saturday Academy.

CHAPTER THREE

THE CLEVELAND USSAMP PROJECT

One of the USSAMP activities I felt best about . . . was the science and math olympiads. They were planned solely by teachers and involved collaborations between the two schools and between the science and math departments in each school. The olympiads allowed students to gain exposure and experience. They incorporated both competition and self-esteem. — USSAMP teacher

Introduction

Cleveland Public Schools (CPS) is the largest school system in Ohio with 127 schools, 19 of which are intermediate schools. The school district is 70 percent African-American and 30 percent white. The district has a history of providing innovative, nontraditional opportunities for students. Among these are a variety of theme and magnet schools at the high school and middle-grades levels, including the Cleveland School of the Arts (grades 4-12), emphasizing music, dance, and theater; the Cleveland School of Science (grades 6-12), featuring nontraditional approaches to teaching science and related technologies; and a technology magnet school, in which students learn basic skills by using computers and other technology.

The school district has a variety of strong collaborations with local business and industry, the largest of which is the Cleveland Initiative for Education. This includes a scholarship program that assists students in grades 7-12 on the basis of academic achievement; a school-to-work program, which provides job training and placement; and Education Partners, which pairs schools with businesses that provide them with a range of academic and nonacademic supports. Given its history of providing students with a variety of educational programs, CPS viewed USSAMP as an excellent vehicle for improving middle-grades mathematics and science education.

The Planning Period

The Cleveland planning team formed late in 1988; it consisted of the district science and mathematics supervisors, one middle-grades mathematics and one middle-grades science teacher, the director of general edu-

cation, and a member of the CPS Research and Analysis Department. The group held a two-day planning retreat in January 1989. Among other things, the retreat produced a set of objectives designed to train teachers to move from teaching arithmetic mechanics to teaching mathematical concepts and problem solving, and from a textbook-focused science to an activity-based approach. Following the retreat, the team drafted a proposal for achieving these objectives, and the project began in August 1989. During the planning period, a 30-member advisory committee was formed. It included representatives of the Office of Youth Development, the TRW Corporation, Cuyahoga Community College, the Cleveland Parks and Recreation Department, and the Cleveland Education Fund.

The Target Schools

Early in the planning period, two middle-grades schools — Central and Lincoln Intermediate Schools — were chosen to become demonstration sites for modeling activity-based, student-centered instruction in science and mathematics. In 1989, Central had 615 students, of whom 60 percent were African-American and 40 percent were white; Lincoln had 490 students, of whom 41 percent were Latino, 37 percent were African-American, and 17 percent were white. The schools were average in terms of student achievement.

The department chairs in mathematics and science from both schools had been involved in the USSAMP planning process. The Central mathematics chair was also involved in a district prealgebra project, and one of the science teachers at Lincoln was the only teacher in Ohio trained in Activities to Integrate Mathematics and Science, an interdisciplinary approach to teaching those subjects. Together, the two schools had 17 mathematics and science teachers, and each school had an enthusiastic core group of teachers eager to use the grant to implement activity-based approaches in mathematics and science education.

Middle-Grades Mathematics and Science Education

The assessment of middle-grades mathematics and science education undertaken during the planning period revealed a situation similar to that in the other two USSAMP cities and the country as a whole. In general, instruction was textbook-bound and limited to lectures, with no laboratory experiences provided in mathematics and few such experiences in science. Furthermore, teachers had limited training in activity-based techniques and provided little such instruction, although the district had pur-

chased hands-on materials, computers, video cameras, and a VCR for each intermediate school science department.

On the other hand, the assessment cited the newly revised, activity-based mathematics and science curricula and a number of successful programs and collaborative initiatives. These included a program involving CPS, Ohio State University, and the Ohio Board of Regents to introduce all students to prealgebra; Invent America, a program designed to stimulate creative thinking and problem solving; Family Science Saturdays, a program at the elementary level, designed to involve parents in their children's science education; and the Cleveland Science and Mathematics Collaboratives, which brought together secondary school science teachers and local scientists from industry, universities, and education-related civic organizations.

Program Description

The major goals of the Cleveland USSAMP project were to improve student achievement in mathematics and science; increase the number of African-Americans, Latinos, and females enrolling in higher-level mathematics and science courses; and enhance student awareness of potential careers in mathematics, science, and technology. To achieve this, the project undertook the following programs and activities:

- An activity-based, student-centered program of instruction in mathematics and science, to be used with the proposed revised science and mathematics curricula
- Ongoing professional development to enhance the curricula
- Science and mathematics clubs, fairs, and competitions
- Career awareness activities
- Self-esteem activities
- Compilation of a resource guide to assist teachers in implementing the student-centered instruction
- Sessions to involve parents in their children's mathematics and science education

Activity-Based Instruction

Science and mathematics classes in project schools offered students a variety of activities to provide them with hands-on learning experiences. In science class, students worked in teams, studying the effect of heat on compounds and of smoking on the respiratory system; and the difference

between compounds and mixtures, and between various types of solutions. In mathematics classes, teachers encouraged students to pose questions, solve problems, and apply mathematics skills to everyday situations. Newly purchased equipment — computers, calculators, experiment kits, overhead projectors, computer games, and microscopes — enhanced both mathematics and science classes. The project gave every USSAMP student a scientific calculator, and teachers demonstrated calculator operations by means of an overhead projector.

The project undertook major efforts to integrate mathematics and science skills and learning. As one science teacher put it:

> USSAMP said to us, "You can hook up with the math department." It encouraged us to find opportunities for working together.

At one school, students conducted a soap-making experiment in science class and then used mathematical concepts to determine the volume and surface tension of the bubbles. One science teacher described the effectiveness of the project's integration of mathematics, science, and technology in this way:

> We were all involved in the use of scientific calculators. When I required students to use a function in science lab, I knew they had learned how to use it in math. I take it for granted now. It's a nice feeling to get to that level — technology in the classroom, not just science or math.

Other Mathematics and Science Activities

Various activities enhanced the program, including mathematics and science clubs, classroom mental mathematics competitions, a school banking program, Invent America (described earlier), science fairs, field trips, mathematics and science olympiads, and Young Astronauts (a national network of school clubs where students receive monthly sets of hands-on mathematics and science activities related to principles of astronomy and physics).

Students from both schools participated in the local Invent America Competition, a districtwide event. Teachers attended an orientation session that prepared them to motivate and assist students in developing inventions. Student inventions included a computerized telephone directory, a picture-window wiper and washer, a babyproof socket, a key finder, and a clothesline conveyor. Several inventions received awards in the

competition at the school level and also at the district level — the Invent America Showcase.

The high points of these activities were the mathematics and science olympiads, two competitions involving students from both Central and Lincoln, which took place in the spring of 1991. Lincoln hosted the mathematics event, which featured teams of 25 students from each school competing through five rounds of mental mathematics. Central hosted the science competition, in which teams of 20 students from each school participated. The competition required students to compete in a "quiz kid" tournament, as well as to undertake specific tasks such as testing water displacement with student-built boats and building paper towers. Involved teachers described these competitions vividly:

> After the math and science olympiads, the students were hugging each other and the teachers. You had to be there to see the expressions on the kids' faces!
>
> With USSAMP, the math and science olympiads were so successful, I guarantee we will do them forever! And we will involve the social studies and English departments, and get parents involved!

Students in mathematics and science competitions display their awards

Career Awareness Education

To be motivated, students need to know there is a job for them. And they also need to see minority and female role models in employment related to science and technology. — Cleveland USSAMP teacher

Career awareness education was another component of the Cleveland USSAMP project. Activities included speakers in mathematics and science classes, motivational activities, and a research project in this area. To facilitate the research project, representatives of the CPS Career Education Unit demonstrated the Ohio Career Information System, accessible by computer in the target schools' media centers and provided information about many other career resources available to teachers and students. Using this information base, students were involved in the production of two career awareness videos. Students at Lincoln researched careers, chose specific ones, wrote interview scripts, played the roles of interviewers and career models, and videotaped the interviews. In addition, nine students chosen as interviewers identified and interviewed four African-American and female professionals. In June 1991, at the 12th annual Telly Awards, the video, *How to Interview Role Models*, won an award for the school.

Self-Esteem Building

Self-esteem building was an important component of the Cleveland project. Members of the school-based planning teams felt that raising student potential to achieve in mathematics and science involved building students' confidence about their ability to do well in these areas. They viewed the grant as an opportunity to do much more than upgrade the technology. As one involved teacher said, "Equipment enhances education but may not change student attitudes. We had an attitudinal focus first."

Working in teams students conduct experiments, learning scientific concepts through direct hands-on experience

Teachers used the Phoenix self-esteem building curriculum, and students used personal planning notebooks to help develop study skills and set long- and short-term educational and employment goals. Among the numerous self-esteem activities were a poster contest and displays of student work in halls and other community facilities. The credo "If it's to be, it's up to me," taken from the Phoenix curriculum, was chanted before class and printed on T-shirts and sweatshirts which the project distributed. Students also created another motto: "I know I can, I know I will, I know I must."

The project's approach to developing student self-esteem was active: it was based on providing students with multiple experiences in which they could develop competency and experience success. As one teacher explained:

> Doing motivational lectures — that is, with sports stars — doesn't work. Words are cheap — the kids know the reality. We learned that the students hated the movies that we showed them early on about self-esteem. They didn't want to be lectured to. But to do group work — in half an hour have them build a tower with strips of paper and paper clips and develop a skill that blows their mind, and yours, through accomplishments, not arbitrary words — now that builds self-esteem!

Professional Development

Both initially, in August 1989, and on an ongoing basis, teachers received in-service training from district mathematics and science coordinators, and from staff of the mathematics and science departments of a local university and the Cleveland Science and Mathematics Collaboratives. Teachers, principals, and paraprofessionals from the two schools participated in training on a variety of the following topics:

- The newly revised mathematics and science curricula
- Strategies and activities designed to shift the focus in teaching from textbooks to activity-based learning, cooperative learning, problem solving, mental mathematics, and computer-based instruction
- Strategies and enrichment activities to include parents and families in their children's mathematics and science education
- The use of calculators and other scientific equipment

- A number of other relevant concerns, such as assessment and equity issues, using the Phoenix self-esteem program, student portfolios, providing career information, enhancing student self-esteem, and incorporating career awareness information into the mathematics and science curricula

Other Activities

The Cleveland project undertook a number of other activities:

- A resource guide of hands-on instructional activities was drafted, as was a resource package of guidance materials and supports for use by mathematics and science teachers to reinforce self-esteem.
- Activities to involve parents in mathematics and science education took place, including a workshop for parents at a local community college led by Lincoln and Central teachers. USSAMP staff also incorporated mathematics and science activities into parent meetings and school open houses.
- A student data base on which to gauge improved student achievement was developed. The data base included students from the two project schools and two comparison schools similar in terms of student population and achievement. This base was used in the end-of-project evaluation conducted in the spring of 1991.
- Teachers from the two schools attended the regional, state, or national conferences of the National Science Teachers Association or the National Council of Teachers of Mathematics.

USSAMP Continued

The basic elements of the Cleveland USSAMP project are still in place in the two schools: increased activity-based learning; the focus on problem solving and mental mathematics; the use of scientific calculators; and participation in schoolwide, citywide, and statewide competitions. In 1990, Central students participated in the Cleveland Minorities in Engineering Forum science fair and preengineering program; in the spring of 1992, they participated in the Ohio Mathematics League competition, a MATHCOUNTS competition at a local college, the Greater Cleveland Council of Teachers of Mathematics Competition, and a schoolwide mathematics and science olympiad. In spring 1992, Lincoln students participated in the Cleveland Minorities in Engineering Forum events; their participation culminated in the creation of an engineering design project. The six students with the highest ratings received a trip to the Wright-Patterson Air Force Base and Challenger Museum in Dayton, Ohio.

CHAPTER FOUR

THE DETROIT USSAMP PROJECT

To me, Academic Games means believing and achieving in mathematics. The Equations game has really helped my mathematics grades. My average was B-, but since I joined the team, I'm a straight A student in mathematics. — Detroit USSAMP student

Introduction

Detroit Public Schools (DPS) is the seventh largest school district in the United States. Its 256 schools serve approximately 170,000 students, roughly 90 percent of whom are African-American. Over the years, the school district has adopted a number of innovative programs and approaches to improve the educational achievement of all its students. Most recently, DPS developed, and its Board of Education adopted, a Design for Excellence, a comprehensive plan outlining major goals to improve the schools. The four goals of this plan are to create new kinds of schools, providing choices for parents and students; ensure management and organizational effectiveness through administrative revitalization and professional development; guarantee student success, both overall and as reflected on standardized tests; and build community confidence through effective outreach, increased adult education programs, and expanded parent and community participation in the schools.

Given the district's concerns to enhance education for all its students, USSAMP provided an excellent opportunity to increase students' mathematics and science achievement.

The Planning Period

In response to AED's invitation to participate in USSAMP, the district assembled a planning team, which included district-level administrators; elementary, middle-grades, and high school science and mathematics supervisors; and professors of mathematics and science from local universities. The major activities of the planning period were assessing the strengths and weaknesses of mathematics and science instruction in DPS, planning a two-day retreat, designing the program, and writing the proposal. At the retreat, the planning team was expanded to include many

administrators and teachers, including representatives from the five middle-grades schools chosen to participate in the program.

Another activity of the planning period was the formation of an advisory board to elicit support from business and industry for the project. Board members were representatives of the five schools, the Ford Motor Company, General Motors, the Detroit Science Center, the Metropolitan Church of God and Christ, Wayne State University, Education 2000 (an educational consortium), and New Detroit, Inc. (an urban coalition established to foster partnerships between the public and private sector).

The Target Schools

Superintendents from five DPS areas chose one middle-grades school to participate in USSAMP. This selection was based on the school's California Achievement Test (CAT) and Michigan Educational Assessment Program test scores and on the area superintendent's sense that particular schools had the potential to improve instruction in mathematics and science and to enhance student achievement in these areas. The five middle-grades schools, with a total student population of 4,400, were Beaubien, Brooks, Cleveland, Halley, and Whitney Young. The principals in all the chosen schools were committed to the goals of USSAMP — also an important factor in selection. However, all students in the schools did not receive a full year of science instruction every year; many did not receive algebra instruction at all, and those who did, typically studied it for less than a year. In 1988-89, all schools had scored within a grade level of the national average on the eighth-grade CAT.

Middle-Grades Mathematics and Science Education

The planning team identified various strengths and weaknesses of existing educational practices in mathematics and science in the middle grades, and used these as guides in developing the USSAMP project. Among the strengths in mathematics education was the curriculum, which reflected new directions in mathematics education and ongoing professional development to enable teachers to use the curriculum. One weakness was that many middle-grades mathematics teachers had not majored in the subject in college and had a limited background in the area. They lacked knowledge of new content and appropriate, effective, and innovative teaching strategies. The planners also identified a great need for hands-on materials to heighten student understanding of abstract mathematical concepts.

In science, the planning team cited the existence of a citywide curriculum bolstered by a handbook of activities to infuse technology and social issues into the curriculum. The team also noted the ongoing professional development of teachers and the excellent participation of DPS middle grades students in the Detroit Science and Engineering Fair. However, the team found that middle-grades students did not receive sufficient science instruction; indeed, science was an elective in many schools. And, as with mathematics, many science teachers were ill prepared to teach their subject effectively.

Program Description

> *We wanted to develop model lessons that would infuse strategies into content. We knew that students need experiences that build on prior knowledge and that we had to create hands-on activities that help students acquire skills and knowledge. But we knew we couldn't stop there: we had to move to integrate those activities so that students could construct knowledge and reflect on that knowledge and apply it to real-world situations. We had to help students see how science and mathematics applied to their personal lives and could lead to interesting future careers.* — Middle-schools science supervisor and member of USSAMP planning team

On the basis of its assessment, the planning team designed a program with the following major goals:

- Increase the amount of time devoted to mathematics and science in the targeted schools.
- Make the mathematics and science curricula more activity-based and experiential by infusing it with hands-on activities to enhance student learning and achievement. The planners considered this goal especially important, given research showing that, while all students benefit from participation in activity-based classrooms, students from academically or economically disadvantaged backgrounds especially benefit from this approach.
- Increase student awareness of the contributions of Africans and African-Americans to mathematics, science, and technology. Originally, as described in the proposal, these efforts were designed to "unravel the threads of African genius so that students [would] be empowered with knowledge and with greater self-esteem, fostering positive feelings towards schools in general and science and mathematics in particular." Ultimately, this

focus was expanded to encompass a multicultural perspective on the teaching of mathematics and science.

- Provide a transition from arithmetic to algebra.
- Provide a major focus on cooperative learning. This concern was based both on research showing that teaching approaches stressing working alone or competitively may not be the most effective for African-Americans, Latinos, and females and on a sense that cooperative learning is more reflective of "real-world" situations.
- Provide students with a range of career awareness supports, including increased academic and career guidance, career awareness seminars, and field trips.
- Increase the involvement of families in their children's science and mathematics education.

The Saturday Institute

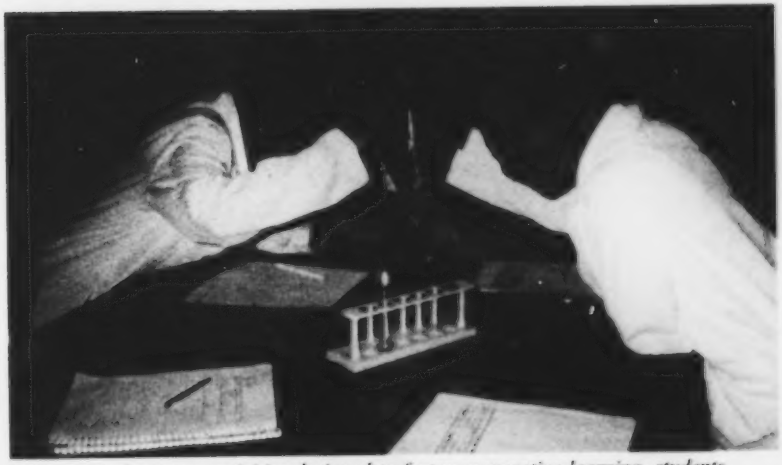
Enhanced professional development was clearly crucial to the effectiveness of many of these planned activities. Consequently, the Detroit USSAMP project launched a major professional development initiative to radically change the way science and mathematics were taught in participating schools. A Saturday Institute was established, in which an extensive series of professional development sessions took place during the winter and spring of 1990. Many mathematics and science teachers from USSAMP schools attended the sessions and received stipends for participation. Staff from local universities and members of the AED technical assistance team provided the training.

This component of the project sought to enhance existing professional development, keep teachers abreast of new content and innovative strategies, sensitize teachers to the needs of African-American and female students, and increase teachers' comfort-level in teaching mathematics and science. These efforts included use of the following:

- The University of Chicago School Mathematics Program, to enable teachers to use the transition mathematics approach to provide a bridge for seventh graders from arithmetic to algebra and to deliver an eighth-grade algebra curriculum
- African-American Contributions to Science and Technology, a series of lessons to help teachers integrate information about the contributions of Africans, African-Americans, and other minorities into the curricula

- Science Helper, an on-line teacher directory providing model lessons in activity-based instruction and activities to enhance the science curriculum
- The EQUALS program, a national teacher education program that provides methods and materials to assist K-12 teachers address the special instructional needs of African-American, Latino, and female students and to increase the achievement of these students in mathematics, science, and computer courses
- Cooperative learning (the Johnson and Johnson approach)
- Family mathematics and science programs, providing techniques for involving families in mathematics and science education
- Academic Games, which utilizes game-based instruction to improve student mathematics attitudes, knowledge, and skills; and MATHCOUNTS, a coaching program entailing progressive competitions designed to produce high levels of mathematics achievement
- Middle Grades Mathematics Project, a series of guides designed to help teachers develop student problem-solving skills through a series of activity-oriented exercises
- Activities to Integrate Mathematics and Science, an interdisciplinary approach to teaching these subjects
- Computers, calculators, video, and other technology designed to enhance the science and mathematics curricula

At these Saturday sessions, staff were able to develop model lessons integrating mathematics, science, and computers and undertake "lesson tryouts" for their peers and supervisors. Teachers were also able to review materials — such as those in Science Helper and African-American Contributions to Science and Technology — that could be best integrated into the new science and mathematics curricula. As a result of this extensive training, participating schools saw dramatic increases in the use of activity-based instruction; the integration of mathematics, science, and technology; and the use of cooperative learning strategies. One middle-grades science teacher summed up the positive effects of this training as follows: "Professional development helped me grow in my confidence in using computers and other technology. And when I grow, my students automatically grow."



In frequent classroom activities designed to foster cooperative learning, students learned to work collaboratively to solve science and math problems.

Other USSAMP Activities

The Detroit USSAMP also undertook numerous other important activities to enhance mathematics and science education in the five participating schools, including the following:

- Increased time for mathematics and science: Under USSAMP, the amount of instruction time for science increased to 225 minutes a week and for mathematics to 250 minutes a week. One of the participating schools required that all students do a minimum of two hands-on science activities a week.
- Piloting of the University of Chicago School Mathematics Program: The project introduced the transition mathematics program in the five schools. To enable DPS mathematics and technology coordinators to train mathematics teachers, staff from the University of Chicago conducted an orientation workshop in January 1990.
- Purchase of materials: With USSAMP funds, schools could purchase many materials to promote activity-based learning in science and mathematics: computers, graphing calculators, laser equipment allowing experiments to be projected on a screen, high-power microscopes, and Science Helper.
- Family mathematics sessions: Sessions to involve families in the mathematics education of their children took place at Cleveland

Middle School. These sessions were the major undertaking of the USSAMP advisory board in conjunction with Education 2000. (Cleveland is located in a community targeted by both Education 2000 and USSAMP.) Other participating schools also held family mathematics involvement activities: as many as 100 parents participated in one session at Beaubien.

- Career awareness supports: The project produced a video with participation of students, providing information about careers in science and technology and showing role models for African-American and female students. Career awareness activities also included a variety of field trips: students visited the Detroit Science Center, the General Motors Technology Center, and the Detroit Area Pre-College Engineering Program.

USSAMP Continued

Four major activities that grew out of USSAMP or were greatly enhanced with USSAMP funds epitomize the Detroit project's ongoing commitment to enhancing mathematics and science education: a growing emphasis on project-based science; the premedical careers program at Beaubien Junior High; increased use of Academic Games; and greater participation in Detroit-area science fairs. According to a middle-grades science teacher, "The common thread of all these activities is that we engage students in activities designed to show them how mathematics and science relate to their everyday lives."

Project-Based Science

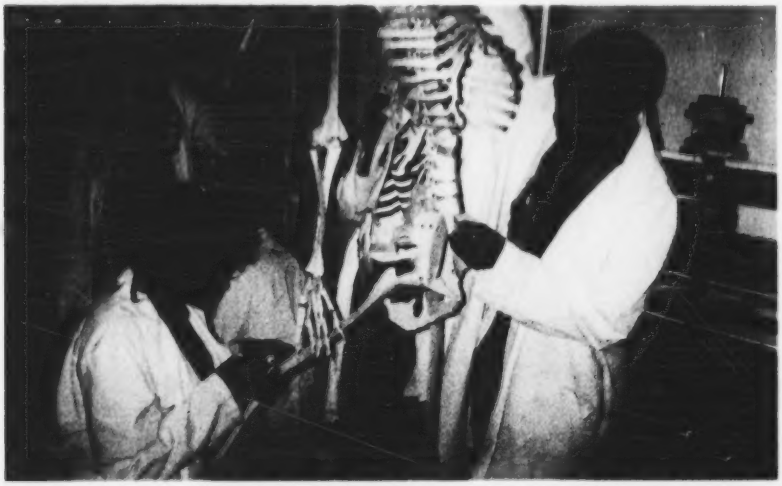
Under USSAMP, schools were able to increase and enhance their focus on project-based science, a special project undertaken in collaboration with the University of Michigan. In this experiential approach to the teaching of science, a series of activities driven by a central question or problem gives rise to new questions, concepts, and activities. Such an approach seeks to engage students in a set of tasks and a process that builds and incorporates a range of skills, such as gathering information, making hypotheses, assembling proofs, and using instruments. For example, in an examination of the question "What's in our water?" students discovered concepts such as watershed, freshwater treatment, wastewater treatment, recycling, and pollution. According to a middle-grades science teacher, "In project-based science, the students are the scientists."

Premedical Careers Exploration Program

Beaubien Junior High developed its premedical careers program in response to the low interest in medical careers on a test to determine student awareness of and interest in a variety of career areas. In 1990, only 3 of the 105 students who took the test showed an interest in careers in medicine and health. The principal of Beaubien concluded, "Students obviously hadn't made the connection between mathematics and science and future careers."

The program introduces students to a range of medical and allied health careers through an ongoing partnership with a nearby vocational technical center and a local hospital. Students apply for the program at the end of the seventh grade. A student essay expressing interest — not grade point average — is the major criterion for admittance to the program. The first year in which the program was offered, the administration expected enough applications to fill one class. Instead the program had over 100 applications and formed two classes of 35.

The program occupies a two-hour time block once a week. Students work on experiments and other tasks with a lab partner whom they choose for the year. According to the principal, "The point is to show students the force of a cooperative approach to problem solving, how working together enhances knowledge and is a useful tool in many real-life situations." Students in the program wear lab coats, donated by Henry Ford Hospital and Medical Center.



Students at Beaubien Junior High construct an adult-size skeleton as one of their assignments in the premedical careers exploration program

Participants in the program gain extensive laboratory experience, conducting dissections, medical research, and written and oral research projects based on scientific inquiry and practical applications. The program includes a component at Crockett Vocational Technical Center. This component exposes students to a variety of health professions, including pharmacy, nursing, medical records, histology, medical laboratory assisting, and dentistry. Students clock in at the school and follow older students in one of these career areas. Students in the program also gain exposure to a range of health professions through speakers and field trips to collaborating health and medical facilities.

The program has several important foci, including a strong emphasis on physiological systems and processes. Students learn through the use of manipulatives, dissection of preserved specimens, and working with torso models with removable organs. One task requires students to construct a paper adult-size skeleton, bone by bone, without written instructions. Computer applications is another important part of the program: one interactive software program allows students to play the part of a doctor on hospital rounds, encountering actual problems and making decisions about patient care.

Participation in the city science fair is an important part of the program. Students study issues related to health, such as the relationship between pulse rate and exercise. All students in the program undergo CPR training, and many have become certified.

Initially, USSAMP provided materials and supplies for the premedical careers program, as well as funds for professional development. The program now receives support from universities, businesses, hospitals, science grants, and Crockett Vocational Technical Center. According to the principal, the program "makes theory come to life through community outreach and collaborations." It has increased student interest in medical and other allied fields careers: on the most recent test of student interest, 58 students in the program and 12 outside it chose such careers.

Beaubien Junior High also offers students a number of other career exploration programs, including ones in engineering, computer science, and television and radio broadcasting.

Academic Games

> *Academic Games are terrific. It helped me with mathematics and English. Without it, I would not be in algebra today.* — USSAMP student

Academic Games, another activity that was enhanced under USSAMP, utilizes game-based instruction to improve student attitudes, knowledge,

and skills. A middle-grades mathematics teacher, who uses Academic Games extensively, described them enthusiastically:

> How often have you heard students say that mathematics is boring and they just can't do it — their mother couldn't do it. Well, Academic Games is an excellent vehicle for creating a stimulating learning environment, for improving logic and problem-solving, and for reaching a diverse group of students working towards common goals.

The academic games approach was developed in Detroit in the early seventies, and in 1976 training for all middle-grades mathematics teachers was provided. Presently, over 1,500 students from all levels are involved. The Detroit USSAMP project chose to focus on the mathematics games, particularly Equations, in which students learn mathematical skills and algebraic ideas; Onsets, which introduces students to set theory; and Wff'N Proof, which teaches symbolic logic and develops students' higher-order thinking skills. Students work cooperatively in teams in these games. Teams contain students with various abilities, who teach each other the skills needed. The games grow in complexity as the players' understanding matures.

Teams engage in monthly competitions with schools throughout southeastern Michigan. Once a year they participate in the statewide Super Tournament of the Michigan League of Academic Games (MLAG) and in the National Academic Games Olympics; DPS students have done extremely well in both. A Detroit team won its first national championship in mathematics in 1978, and in the words of the middle-schools science supervisor, "After that our students just kept winning and winning!" At the 17th annual MLAG, in March 1991, teams of middle-grades students from DPS won 25 division championships in mathematics and logic. Students from one of the USSAMP schools, Halley Open Middle School, won more championships than students from any other school.

Students are enthusiastic about Academic Games. One student said:

> All students should have Academic Games. It provides a very positive experience. I have learned how to be a good winner and loser. I have discovered some interesting applications in mathematics and discovered that learning can be fun.

Another student commented:

> Academic games has not only taught me math, grammar, and logic. It has also taught me self- control. It has taught me how to have self-esteem and be humble at the same time.

> I think Academic Games promotes growth, spiritually and mentally. You get a sense of pride and self-worth.

Increased Achievement in the Metropolitan Science Fair

Under USSAMP, participation of targeted schools in the Metropolitan Detroit Science and Engineering Fair also increased. Overall, there are eight fairs, with all public, private, and parochial schools in three counties competing. DPS students have been extraordinarily successful in these fairs. In 1992, in which 92 schools participated, DPS students won 1,364 awards, including 264 gold awards (which include the grand prize, and first-, second- and third-place prizes). Halley Open Middle School has been particularly successful in this event. In 1987, the first year in which Halley competed, it won 28 awards, seven of them gold. In 1992, Halley students entered 71 projects, and every project received a prize, including 36 gold — more than any other school received. One class alone, of 35 students, won 18 prizes, including 10 gold.

Cooperative learning is an important aspect of how science is taught at Halley. In science class, students work in teams; each team is assigned a particular task to accomplish and then reports to the entire class. According to the school's principal, this approach "shows students the power that cooperative learning brings to the class" and lies at the root of the school's extraordinary success in the fair:

> Cooperative learning is the key. When kids do it themselves, when they support each other, they realize that as a group they can do it on their own — they can do it without teachers. When they work together, they become — not average — but great!

This faith in students is the foundation of DPS's continued efforts to enhance mathematics and science education for all its middle-grades students.

CHAPTER FIVE

LESSONS LEARNED

All three USSAMP projects undertook evaluation as part of the conditions of the grant. As of fall 1992, Cleveland and Detroit had completed their evaluation. The Atlanta project will complete its major evaluation by the end of 1992 and a follow-up longitudinal study in the spring of 1993.

Both the Cleveland and the Detroit evaluations found that the projects had helped teachers integrate activity-based instruction and self-esteem and career awareness activities into their educational programs. Both also concluded that the projects had generated enthusiasm for mathematics and science among teachers and students alike, and improved student knowledge of possible careers in science and technology. In Detroit, the number of students from the junior high school with the premedical careers exploration program applying to the collaborating technical vocational center has increased; and in Atlanta, the number of students applying to magnet high schools in mathematics and science, computers, and engineering has grown markedly. Further, the responses of students, teachers, and administrators throughout this report reflect the benefits of the approaches epitomized by USSAMP.

A wealth of information and lessons emerged from the USSAMP experience. These lessons are useful for any program geared to enhancing the academic achievement of students who traditionally have not been well served by the schools; specifically, they pertain to initiatives aimed at enhancing middle-grades mathematics and science education. Some of the lessons derive from barriers that projects encountered in initiating and implementing activities. For example, all three USSAMP cities experienced at least one change in superintendent during the course of the project. All three projects also needed more time to plan and implement activities than the grant allotted.

Summarized below are many of the lessons and experiences of USSAMP activities. This summary also includes the experiences of other schools, programs, and districts involved in the reform of mathematics and science education, as described by individuals who attended the USSAMP conference in May 1992. The summary is based, in addition, on the experiences of other schools and districts working on middle-grades mathematics and science education, with which AED has worked in recent years. Some of these lessons pertain to undertaking middle-

grades mathematics and science reform activities, and some pertain to undertaking educational reform activities in general.

An Underlying Vision

An underlying vision must inform efforts to improve the mathematics and science achievement of African-American, Latino, and female students. This vision must be fueled by high expectations of all students and by the conviction that African-American, Latino, and female students can attain high levels of achievement in mathematics and science, given effective teaching and supports. All those involved in the mathematics and science education of youth must help to develop this vision: school and district administrators; teachers; parents, students; and representatives of community-based organizations, businesses, and industry. Without such an underlying vision, changes in curricula, teaching, and assessment are likely to be add-ons to existing practice rather than fundamental changes.

The Importance of District-Level Support

Strong leadership at the district level is critical to reform efforts. Ideally, there will be an individual at the district level who can articulate the vision and keep it in the forefront, especially when barriers arise. In the absence of a major commitment at the district level, programs at the school level suffer, even with the most enthusiastic principals and teachers. In many cases, although not always, a committed individual at the district level can help eliminate bureaucratic problems that inevitably arise in any large school system and can network among district staff and secure valuable additional resources. As a member of the AED technical assistance team put it:

> It is important to have someone at the district office with the vision which remains intact no matter how many obstacles arise, someone who has the power to get things done — who can cut through the red tape. The vision remains no matter how many changes occur.

Committed support at the district level is also crucial in terms of sustaining programs through changes in superintendency, mobilizing support for policy changes, and institutionalizing effective programs.

The Building Principal

Such a vision also must exist at the building level. A district-level coordinator expressed it thus:

> We have to have a vision in the district office, but we must also involve the school. I can't make the vision a reality from my office. It has to become reality through work at the school.

The building principal plays a vital role in keeping the vision alive and in providing support for new programs and approaches. Principals were especially critical in assuming ownership for USSAMP, inspired by what one principal described as a "long love for the disciplines." Another USSAMP principal remarked:

> It is critically important to sell the program to the building-level principals. The superintendent runs the show, but if you want to get something done, you're going to have to convince the building-level principal that it's something worthwhile for the children — that they should be out there on the cutting edge.

Many individuals spoke of the changing role of the building principal — both as an instructional leader and as a broker in terms of obtaining funding and support. One USSAMP principal said:

> We want to do things that are good for the students, and we end up doing all sorts of things — looking for supports and funding, asking corporations for help — because we want to help the kids.

The Planning Period

A number of individuals involved in USSAMP attested to the importance of the planning period. Planning programs collaboratively is especially time-consuming and often difficult for large school districts. It takes time to develop a process for working together and for communicating effectively.
A teacher involved in USSAMP said:

> Collaborative leadership was a new experience for us, and the way that AED worked with us was relatively new. We were not fully equipped to deal with it.

The USSAMP projects received funding to cover a six-month period, but all three projects found that this amount of time was inadequate —

that a year of planning was necessary to initiate innovative mathematics and science activities.

The USSAMP experience underscored the need to involve school staff — teachers and administrators — in planning innovative school-based projects right from the start. Teachers and principals were involved in USSAMP planning teams. A district administrator involved in the program commented:

> School leadership is school leadership, and it *has* to be at the school level. We realized later that the majority of the program planning should have been in the hands of the building principal and his people.

The Importance of Technical Assistance

Schools and school districts need assistance in undertaking new and innovative programs and activities that involve them in collaborative relationships with businesses, corporations, industries, colleges and universities, families, and community-based agencies. Technical assistance can help set in motion dynamic partnerships geared to bring about effective and lasting educational change. Throughout USSAMP, the AED technical assistance team provided help to the projects through workshops, site visits, and provision of resources and information about emerging research and effective practices in middle-grades mathematics and science education. The program also provided two national conferences to give participating administrators and teachers opportunities to keep abreast of new research and to share information and strategies with other educators engaged in similar work.

Ongoing Professional Development

"You can't do anything," one USSAMP principal asserted, "without ongoing, intensive and enhanced professional development." All three projects made professional development a key element of their program. One teacher remarked, "If we are going to initiate change in this district . . . the bottom line is quality of instruction in the classroom and interaction of student and teacher." Professional development provides teachers with ongoing opportunities to keep abreast of the latest research and to increase their knowledge of appropriate curricula and teaching strategies. In implementing policy shifts — such as making algebra a requirement for all students — districts must provide teachers with sufficient training in curriculum content and instructional strategies. Such training and

opportunities for continuous feedback and reflection can help overcome resistance to nontraditional approaches.

Experience suggests that ongoing time for planning and collaboration among teachers is another important aspect of effective efforts to reform mathematics and science education — and efforts to improve teaching and learning in general. In addition, teachers need opportunities to network, and to attend workshops and national and state conferences. Many teachers spoke positively of the opportunities that USSAMP afforded them for sharing and networking with their colleagues. One teacher stated:

> One of the best things for me was the opportunity to attend state and national conferences: this gave me a sense of what others were doing and of how we measured up as a district.

The Contributions of African-Americans, Latinos, and Females

Teachers and administrators involved in USSAMP were emphatic about the importance of educating students about the contributions of African-Americans, Latinos, and females to mathematics and science. Such an emphasis is crucial, according to one teacher, to show students in these subgroups "that they have a history in these subjects" and to help them make a vital connection with mathematics and science as areas in which they can excel. Infusing the curriculum with information about African and African-American contributions to mathematics and science was an important part of the Atlanta and Detroit projects. The Cleveland project emphasized present-day African-American, Latino, and female role models of achievement in these fields. As the dean of a collaborating university described it:

> It is vital for students to learn of the contribution of African-Americans, Latinos, and women in these fields. We have to correct history here.

Access to Algebra in the Middle Grades

One of USSAMP's major assumptions was that access to algebra was a critical factor in determining African-American, Latino, and female students' access to advanced high school mathematics and science courses and to careers in science and technology. Many individuals involved in the program corroborated this assumption. They spoke repeatedly of algebra as the "gatekeeper" to advanced mathematics and science. Teachers

described providing access to algebra as perhaps the most important issue entailed in increasing the numbers of African-American, Latino, and female students interested in pursuing advanced mathematics and science courses and able to do so. A USSAMP principal stated:

> It isn't just algebra. We're trying to teach a whole level of conceptualization — but if you don't know algebra, you don't know the language. It's like going to a interview for a job that you know you can do, but everybody there is speaking a different language.

Providing access to algebra for all students in the middle grades clearly represents a major challenge to many urban school systems. It involves rethinking and changing practices — such as tracking (grouping students by perceived ability, as evidenced on standardized tests) that hinder access to algebra, and teaching approaches that focus on mastery of arithmetic facts before progressing to more complex skills.

While the program did not specifically direct projects to eliminate tracking (this would have been an overwhelming task), it encouraged them to take whatever measures they could to increase students' access to algebra. Projects undertook this in a variety of ways: by increasing the number of prealgebra and algebra classes; by enhancing teacher competence and comfort level in teaching prealgebra and algebra; and by providing tutorial and other supports to help students excel in these classes.

Individuals involved in USSAMP projects and in other innovative mathematics projects have spoken of teachers' and parents' resistance both to the concept of algebra for all students and to eliminating tracking. Teachers, administrators, and parents fear that standardized scores will decrease if tracking is eliminated. Some school systems using the transition mathematics approach have encountered resistance, partially because of the amount of writing required for both teachers and students. Many involved attested to the importance of ongoing professional development and networking to overcome these barriers. One USSAMP coordinator observed, "We haven't changed the mind-set of all our teachers in terms of their expectations of all students taking algebra, but we are working on it."

Despite the difficulties, some USSAMP educators spoke persuasively of the importance of dealing with tracking and tracking policies head-on. One principal remarked: "Are we not pioneers in this, and if not, at what cost to our youth?"

The Involvement of Families

Activities involving families are often an important part of programs seeking to enhance student achievement in mathematics and science. Such activities frequently address parental attitudes about mathematics and science; some seek to allay parental concern that new approaches emphasizing conceptual and problem-solving skills will interfere with their children's learning of arithmetic facts. All three USSAMP projects had some activities geared to families, and participants agreed that while parental involvement may be difficult to accomplish, programs must work to keep parents involved and informed.

A Community of Support

"You can't do it alone," said one member of the AED technical assistance team. "You need the support of families, business, institutions of higher learning, and the community at large. You have to create a community for mathematics and science education." All USSAMP projects sought to develop community support for mathematics and science education by forging collaborations with colleges, universities, businesses, and industry. Collaborations with colleges and universities enhance program planning and professional development, and often increase the range and kinds of activities available for students. Collaborations with the business community are especially important in efforts to convince students that achievement in mathematics and science can lead to future careers.

Activity-Based Instruction

Repeatedly, individuals involved in USSAMP said that making the teaching of mathematics and science activity-based and student-centered was the key to enhancing the achievement of African-American, Latino, and female students. Similarly, many spoke of enabling students to make connections between mathematics and science and real-world situations. One district coordinator asserted:

> You have to help students construct mathematics and science knowledge from their own experience. They have to see that what they are learning in the classroom has a meaning in their everyday lives.

A number of teachers also felt that fostering cooperative learning among students is crucial — both because "of the power such an approach unleashes in the classroom" and because cooperative learning and working in groups help develop skills needed in many on-the-job situations.

Building Student Confidence

The USSAMP experience illustrated the importance of building students' confidence and self-esteem in mathematics and science. An important part of this is helping students to understand that, as one principal put it, "Learning and achievement in school are the consequences of effort, not innate ability." USSAMP staff described giving students multiple opportunities to build competencies and experience success in mathematics and science as pivotal in building their sense of confidence. Some staff felt that an important part of helping students succeed was helping them set long-term educational goals and understand the connection between present educational achievement and future educational and employment possibilities.

An Ongoing Process

The projects found that what they accomplished under USSAMP in planning, implementing, and revising innovative programs to enhance the achievement of youth was just the beginning of a continuous interactive process involving teachers, administrators, parents, and representatives of businesses, industry, and community-based organizations. In one USSAMP school, a teacher said that after several years of activity, they were "just at the brink of starting this project." Another in the same site said:

> As a result of USSAMP, we've begun those dialogues where we all know what is expected of each other. We had a meeting with the finance people. Before USSAMP, we'd never been in the same room together!

Trusting the Kids

Perhaps most important, many USSAMP teachers, principals, and district administrators spoke repeatedly of the importance of having faith in the students, listening to them, and asking for their input. One teacher reported:

> I asked the students at the end of the year to list what things they liked. I found out that they liked the same things teachers liked — to take ownership, to be involved in planning, to be allowed to discover things rather than to be told.

One principal expressed this feeling — and the feeling that was the foundation of USSAMP — most movingly when he said:

> These kids are powerful! You might not know it if you judge by appearances. You might shut some doors. You have to listen to the kids. You have to trust them!

APPENDIX

USSAMP National Advisory Panel

Shirley M. Malcom
Director
Directorate of Education & Human Resources
American Association for the Advancement of Science

Susan Snyder
Program Director
Division of Teacher Preparation and Enhancement
National Science Foundation

Hilda Crespo
Director of Education
Aspira Associates, Inc.

Carolyn Chesnutt Thorsen
former Executive Director
SouthEast Consortium for Minorities in Engineering (SECME)

Sam Husk
Executive Director
Council of the Great City Schools

Mark Driscoll
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USSAMP Technical Assistance Team

DeAnna Banks Beane
Project Director
Youth Alive
Association of Science and Technology Centers

Walter Bogan
Program Officer
Directorate of Education and Human Resources Programs
American Association for the Advancement of Science

Jeffery M. Johnson
President
Management Plus Consulting & Training Services

Ceasar McDowell
Assistant Professor
Department of Human Development and Psychology
Harvard Graduate School of Education

Robert Moses
Mathematics Educator and Founder of the Algebra Project

RESOURCES

This section contains information about many of the curricula and programs mentioned throughout this report, as well as about other valuable resources for educators and administrators seeking to improve middle-grades mathematics and science education.

CURRICULUM PROGRAM	DESCRIPTION	CONTACT
Academic Games	Academic Games was developed in 1971 by Gloria Jackson, head of the mathematics department at Pelham Middle School in Detroit, with the assistance of Layman Allen, professor of law at the University of Michigan. Academic Games utilizes game-based instruction to improve student attitudes, knowledge, and skills. The major goals are to provide a stimulating and motivating environment; to make learning fun and effective; to increase student ability to think logically; to reinforce and extend student understanding of subject-area concepts and skills; and to provide students from diverse backgrounds an opportunity to share ideas and work toward common goals. The games are structured for different levels of competition: within a classroom, students compete against each other, and teams from participating schools compete in citywide, statewide, and national tournaments. The subject areas include mathematics, language arts, social studies, and symbolic logic. Games grow in complexity from primary grades through college.	Ms. Gloria Jackson Supervisor Middle School Mathematics Detroit Public Schools School Center Building 5057 Woodward St., Rm. 932 Detroit, MI 48202 (313) 494-1615

African-American Contributions to Science and Technology	This booklet was developed by a team of Detroit Public School science teachers and supervisors. It includes strategies for teaching the contributions of Africans and African-Americans to science. Its ultimate goal is to dispel and correct the racist errors of omission and commission in historical accounts and teaching of progress in science. The booklet provides activities, detailed background information, and historical perspectives.	Juanita Clay Chambers Supervisor Middle School Science Detroit Public Schools School Center Building 5057 Woodward St., Rm. 932 Detroit, MI 48202 (313) 494-1610
Algebra Project	The Algebra Project, Inc., is the work of Robert Moses and a group representing two generations of African-American activists who came together to address the crisis in mathematics education among inner-city students. One of their primary goals was to bridge the conceptual gap many students experience between arithmetic and algebra. The Project's transition curriculum for sixth-grade mathematics has been successful in preparing students for college preparatory high school courses.	Cynthia Silva Project Administrator The Algebra Project, Inc. 99 Bishop Allen Drive Cambridge, MA 02139 617-491-0200
COMETS	COMETS — Career Oriented Modules to Explore Topics in Science — has a twofold purpose: to demonstrate to young adolescents that learning mathematics and science concepts can lead to a wide variety of careers; and to encourage these students, especially girls, to consider science-related careers. Modules of supplemental lesson plans for grades 5-9 aim to enable teachers to bring community resource people into their science and mathematics classes to conduct activities demonstrating concepts they use in their careers. The COMET Profiles package includes biographical sketches of women in scientific professions related to topics dealt with in the instructional modules. COMETS is out of print, but a reprinting may be possible in the future.	Dr. Walter S. Smith Director COMETS Department of Curriculum and Instruction School of Education University of Kansas Lawrence, KS 66045 913-864-4435

Cooperative Learning Center (Johnson & Johnson)	The Cooperative Learning Center at the University of Minnesota is focused on conceptualizing the theory of cooperative learning, conducting and summarizing the research on it, and translating the outcomes into strategies for practice. The Center believes that structuring classrooms to allow students to work together increases students' achievement, acceptance of differences in heterogeneous settings, and feelings of self-worth.	Cooperative Learning Center University of Minnesota 150 Pillsbury Drive, S.E. Minneapolis, MN 55455-0298 612-624-7031
EQUALS	EQUALS has established nationwide sites to offer training and assistance to educators. Through workshops that provide challenging and motivating mathematics activities, teachers learn how to persuade their students that taking mathematics in the present helps ensure more options in the future. EQUALS also encourages teachers to invite role-model panels of women and minorities working in mathematics-based fields into their classrooms.	Nancy Kreinberg Director EQUALS Lawrence Hall of Science University of California Berkeley, CA 94720 415-642-1823
Family Math	Developed through EQUALS, Family Math is designed to promote involvement of families in the mathematics education of their children by having parents learn and work on activities with their youngsters. The program provides training for educators and parents who want to offer Family Math courses in their own communities. It includes activities to supplement the school curriculum and materials to enable families to conduct these activities at home.	Virginia Thompson Family Math Lawrence Hall of Science University of California Berkeley, CA 94720 415-642-1823
Family Science	Family Science is modeled after the Family Math program, and is designed to involve parents with their children's science education by having parents and children learn science concepts together.	

National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics (NCTM) has two publications to provide guidelines for the teaching of mathematics. *Curriculum and Evaluation Standards for School Mathematics* establishes a new vision of mathematics education and presents criteria for judging the quality of the mathematics curriculum and methods of evaluation. These 54 standards propose significant changes in what is taught in mathematics classes in grades K-12 and explains how to evaluate the learning that occurs in the classroom. The standards are a result of three years of planning, writing, and consensus building among the NCTM membership and the broader mathematics, science, engineering, and education communities; the business and industry communities; parents; and school administrators.

The companion document, *Professional Standards for Teaching Mathematics*, contains guidelines to help mathematics teachers create a successful learning environment for every student and to promote the professional growth of teachers. Its four sections address standards for teaching mathematics, evaluation, professional development, and support and development of mathematics teachers and teaching.

National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091
1-800-235-7566

Project 2061	Project 2061 is a comprehensive, long-term reform initiative of the American Association for the Advancement of Science. Its ultimate goal is to ensure that all Americans have the understanding needed for life in an environment constantly being changed by technological advancements. Project 2061 is designed to unfold in three phases: Phase I built a rationale for science education reform, published in *Science for All Americans*. Phase II will develop alternative curriculum models and Blueprints for Action. The Blueprints will detail necessary changes in 10 other areas, including teacher education, policy, parent and community involvement, and equity. During Phase III, products of Project 2061 will be disseminated for use by school districts.	Project 2061 American Association for the Advancement of Science 1333 H Street, N.W. Washington, D.C. 20005 202-326-6666
Science Helper	Science Helper K-8 is a CD-ROM (Compact Disk-Read Only Memory) containing almost 1000 science and mathematics lesson plans and over 2000 activities. Taken from major National Science Foundation curriculum projects such as Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), and Science . . . A Process Approach (SAPA), Science Helper K-8 is a powerful tool for teachers, supervisors, and curriculum researchers. Each lesson contains an abstract, which allows users to search for criteria such as grade, subject, content, key word, and find desired lessons quickly. Lessons and abstracts can be viewed on screen or printed out. There are specific computer system requirements.	Science Helper K-8 301 Norman Hall University of Florida Gainesville, FL 32611 (904) 392-0761 ext. 264

Scope, Sequence and Coordination	Scope, Sequence and Coordination (SS&C), a product of the National Science Teachers' Association, is designed to change science instruction in grades 6-12. The basic premises of SS&C are as follows: (1) All students should take the four major sciences biology,chemistry, physics, and earth/space science — throughout their secondary school years; (2) Science curricula should be sequenced appropriately, allowing students to begin with natural experiences they can relate to and then, over several years, encounter increasingly abstract concepts; and (3) The major ideas of the four science disciplines should be integrated through coordinated efforts — that is, developers can design and teach a single integrated course or restructure discipline-based courses.	Dr. Russell Aiuto Director Research and Development Project Scope, Sequence and Coordination 1742 Connecticut Ave, N.W. Washington, D.C. 20009 202-328-5810
University of Chicago School Mathematics Program	The University of Chicago School Mathematics Program (UCSMP) has developed the first 7-12 secondary mathematics curriculum to fully implement the NCTM standards. The most fundamental feature of UCSMP is its focus on upgrading the school mathematics experience of the average student. Transition mathematics, the first year of the program, weaves together three themes — applied arithmetic, prealgebra, and pregeometry — by focusing on arithmetic operations in mathematics and the real world. The use of variables as pattern generalizers, abbreviations in formulas, and unknowns in problems, as well as variable representation on the number line and coordinate plane, introduce algebra. The curriculum also introduces basic algebra skills, and connects geometry to arithmetic, measurement, and algebra.	Carol Seigel University of Chicago School Mathematics Program Department of Education University of Chicago Chicago, IL 60637 312-702-9770

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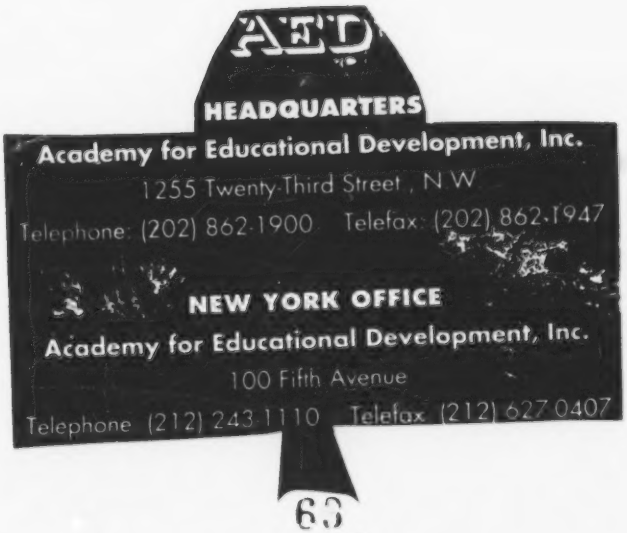
Willard Wirtz: Partner, Friedman and Wirtz; former U.S. Secretary of Labor

Founder: Alvin C. Eurich (1902-1987): President and Chief Executive Officer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